Tetrahedra Video Analysis

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The TikTok video (https://www.tiktok.com/discover/prop-picasso) showing 5 glowing tetrahedra hovering over Phoenix, Arizona, in a slightly curved formation is analyzed to estimate the distance, altitude, spacing and size.

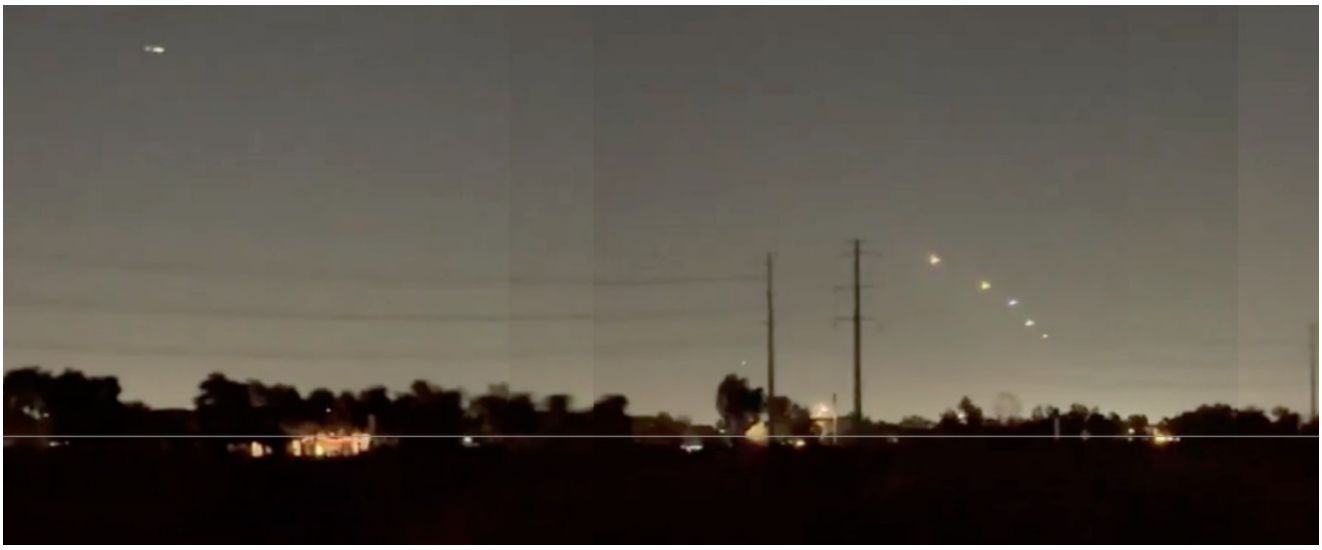

Fig. 1 Panorama of selected frames from the video showing the horizon (thin grey line), an aircraft (top left) and a formation of 5 glowing tetrahedral objects (to the right of the power-line monopoles).

Summary

From the analysis below, it was estimated that the objects were hovering at an altitude of about 38 km (24 miles) and the nearest was about 155 km (96 miles) from the camera. This would appear to be a demonstration of superior technology, since present day space agencies do not have vehicles with hovering capability at that altitude.

Furthermore, the object size was approximately 1500 m (5000 ft), which is much larger than any conventional flying craft. The power required for their light display at the estimated distance would be in the gigawatt range.

These estimates need to be confirmed using images of the same objects taken from a different location in the Phoenix area. Triangulation will allow the map location of each object to be determined, hence the altitude and size.

Location

- The two power-line monopoles in Fig. 1 are identified as part of the electrical transmission lines running parallel to the flightpath of the aircraft seen in the video. The flightpath aligns with the East-West runways of Phoenix airport.
- The larger monopole is part of the 230 kV line running just south of West Lower Buckeye Road in the newly developed part of SW Phoenix, Fig. 2. It is nominally 130 to 140 feet high (Data: https://www.srpnet.com/grid-water-management/grid-management/improvement-projects/abel-

pfister-ball-transmission).

- The smaller monopole is part of a separate 69 kV feeder line, about 0.7 miles (1.1km) south of the flightpath.
- The camera location is devoid of street lighting, suggesting the video was recorded in an industrial area rather than a residential area.
- The camera aim is predominantly to the Northeast, which means the objects are lined up in that direction.

Image Data

- From the apparent sizes of the monopoles, the brightest object is roughly 15 degrees above the horizon. The faintest object is roughly 8 degrees above the horizon.
- Fig. 3 measures the relative heights of the objects and Fig. 4 the relative sizes. The ratios and approximate angles are listed in Table 1.

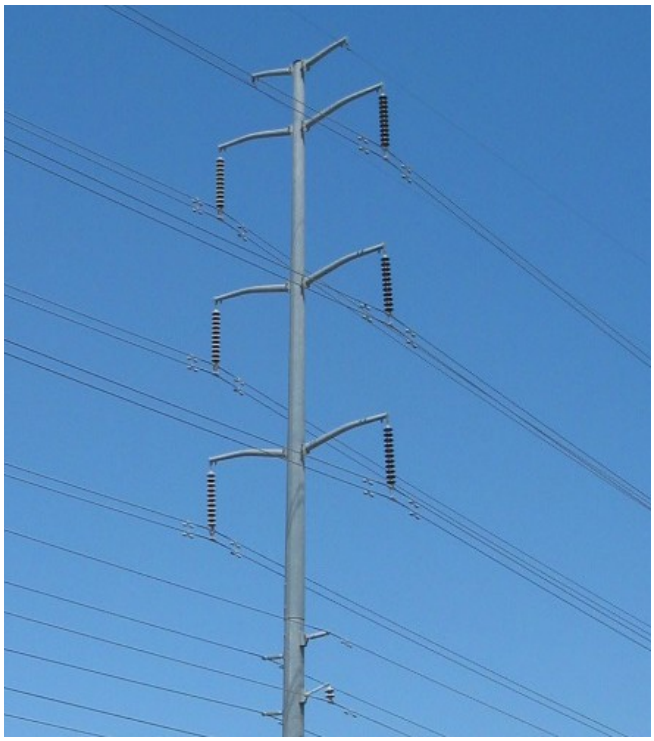

Fig. 2 A 230 kV power-line monopole (https://www.aps.com/en/About/Construction-and-Power-Line-Siting/Power-Line-Siting/Power-Line-Siting-FAQ).

Fig. 3 Enhanced video frame showing relative heights *h* of the tetrahedral objects above the horizon.

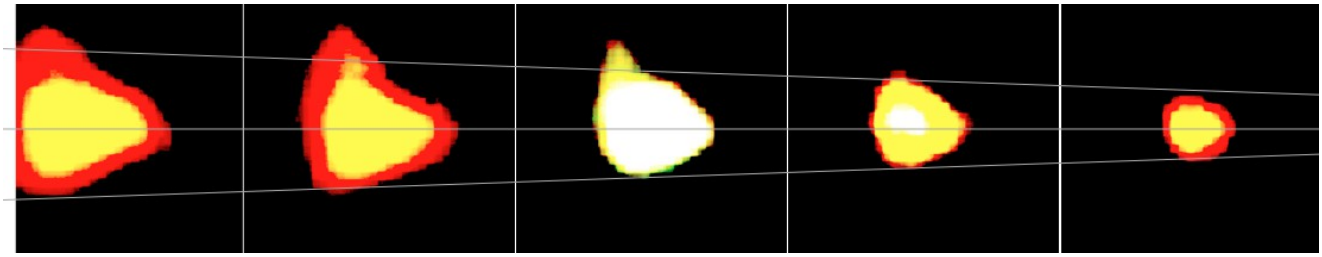

Fig. 4 Enhanced closeups from Fig. 3 showing the relative sizes *x* of the tetrahedra. There is a progression that suggests large distances between equal-size objects.

Object Number i (Left to Right)	Scaled Height $H_i = h_i/h_1$	Scaled Size Factor $C_i = x_i/x_1$	Height Angles θ_i	Size angles $\Delta\theta_i$
1	1	1	15°	0.55°
2	0.832	0.885	12.5°	0.49°
3	0.732	0.744	11°	0.41°
4	0.632	0.615	9.5°	0.34°
5	0.548	0.474	8.2°	0.26°

Table 1 Numerical data obtained from Figs 3 and 4.

Analysis

The curved formation suggests the objects are hovering at such a height and distance from the camera that the curvature of the earth may be apparent, Fig. 5. For the purpose of this analysis, it is assumed that: a) the objects are all at the same altitude h_0, and b) they are all the same size x.

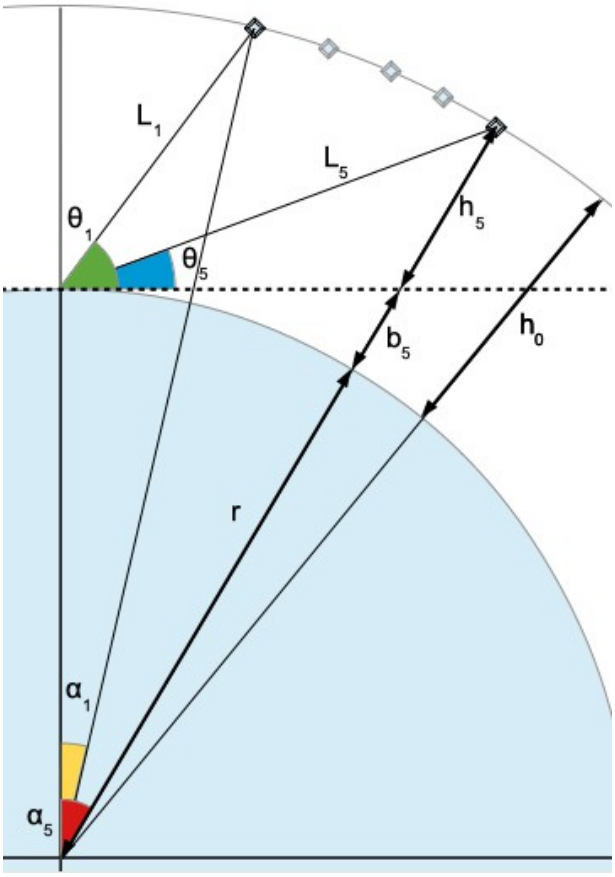

Fig. 5 Geometry of the objects at altitude h_0 above the curved earth surface of radius r as seen by the observer (not to scale). The observer's horizon is indicated by the dotted line.

From Fig. 5, for small angles α_i the relationships between lengths L_i, h_i, r and angles θ_i may be expressed:

$$h_0 = h_i + b_i \quad (i = 1,2,3,4,5) \qquad [1]$$
$$h_i = L_i \sin\theta_i \qquad [2]$$
$$b_i = r\,[1 + (L_i\cos\theta_i/r)^2]^{0.5} - r \qquad [3]$$

where h_i is height above the horizon, b_i the depth below it and L_i is the distance from the camera. Eqn [3] may be simplified further using the approximation $(1+\varepsilon)^{0.5} \approx 1+0.5\varepsilon$, where $\varepsilon << 1$:

$$b_i \approx r\,[1 + 0.5(L_i\cos\theta_i/r)^2] - r$$
$$= 0.5L_i^2\cos^2\theta_i/r \qquad [4]$$

From Eqn [1], the lengths L_i may be related to h_0 by:

$$h_0 = L_i\sin\theta_i + 0.5L_i^2\cos^2\theta_i/r \qquad [5]$$

The apparent sizes in Table 1 provide enough information to predict h_0 and L_i, for example:

$$L_5 = L_1/C_5 \qquad [6]$$

where C_5 is a scaling factor and the factors $0 < C_i < 1$.

The measured angular sizes $\Delta\theta_1$ and $\Delta\theta_5$ of the nearest (brightest) and farthest (faintest) object are in a ratio of 1:0.474, thus the distances L_1 and L_5 are believed to be in the ratio 1:2.11.

Substituting Eqn [6] into Eqn [5], and taking i = 1 and i = 5 to eliminate h_0, the distance to the camera L_1 becomes:

$$L_1\sin\theta_1 + 0.5L_1^2\cos^2\theta_1/r = L_1\sin\theta_5/C_5 + 0.5L_1^2\cos^2\theta_5/C_5^2 r$$
$$L_1^2(0.5/r)[\cos^2\theta_1 - \cos^2\theta_5/C_5^2] + L_1[\sin\theta_1 - \sin\theta_5/C_5] = 0$$
$$L_1 = -2r[\sin\theta_1 - \sin\theta_5/C_5]/[\cos^2\theta_1 - \cos^2\theta_5/C_5^2] \qquad [7]$$

With earth's radius r = 6300 km and the values from Table 1, L_1 = 155 km (96 miles). From Eqn [5], the height of the objects is h_0 = 38 km (24 miles).

The size of the objects is calculated from their size angles, Table 1. For i = 1,

$$x_1 = L_1\tan(\Delta\theta_1)$$

which gives x_1 = 1490 m (4870 ft).